Characteristics of seasonal movement of hazel grouse (*Bonasa bonasia*) in a temperate forest

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Abstract: This study were carried out in the Experimental Forest (37° 48' 10" N, 127° 48' 50" E) of Gangwon Forest Development Institute, Gamjeong-ri, Chuncheon, Gangwon-do Province, Korea from Dec. 1999 to Jul. 2002. Eight individuals (three males and five females) of hazel grouse were captured and they were marked with a 14-g necklace-type transmitter. The surveying results showed that females were more active than males throughout the year, but males were more mobile than females in spring. The degree of movement for females and males was similar from summer to winter. The overlap degree of habitat was very large from spring to autumn. Hazel grouse had greater shifts in area use in winter. They used similar area from spring to autumn, made a shift in their habitat use in winter, and then shifted back to the previous habitat.

Keywords: Activity; Hazel grouse; *Bonasa bonasia*; Korea; Movement
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Introduction

Hazel grouse (*Bonasa bonasia*) is generally considered to be sedentary (Gaidar 1973; Bergmann *et al.* 1982). However, a few researches have noted that hazel grouse has seasonal changes in habitat use and seasonal movements (Ivanter 1962; Swenson 1991b). This bird was even considered to be migratory (Swenson *et al.* 1995).

Dispersal is one of the key processes determining species occurrence and dynamics in a landscape (Wiens *et al.* 1993). Quite a few researchers have suggested that dispersal is not only a reflection of the physical ability of a species to move, but also strongly influenced by a species' behavioral response to apparently hostile habitat (Opdam *et al.* 1984; Dunning *et al.* 1992; Taylor *et al.* 1993).

Two general and not mutually exclusive hypotheses have been proposed to explain seasonal movement or local migration patterns in forest grouse (Hjeljord *et al.* 2000). First seasonal movement of adult was retraced as the dispersal route of juveniles. This seems to be the case in the North American spruce grouse *Dendragapus canadensis* (Ellison 1973; Schroeder 1986). Secondly, the local seasonal movement patterns may be determined by graininess, e.g., the mix of summer and winter habitat (Rolstad *et al.* 1989).

However seasonal movement pattern of hazel grouse was poorly known in Korea. In this study, we investigated the characteristics of seasonal movement of hazel grouse to take the basic information for conservation and management of this bird and its habitats.

Study area

This study was conducted in Experimental forest (37° 48' 10" N, 127° 48' 50" E) of Gangwon Forest Development Institute, Gamjeoung-ri, Chuncheon, Gangwon-do Province, Korea (Fig. 1). The total study area was 170 hm^2. There were several types of forest, such as natural deciduous forest (60 hm^2), mixed forest (40 hm^2), coniferous plantation (38 hm^2), deciduous plantation (19 hm^2), and others (13 hm^2) in the study area (Table 1). The dominant tree species were *Quercus mongolica*, *Ulmus davidiana* and *Fraxinus rhynchophylla*, and *Pinus densiflora* in natural forests. Still *Betula platyphylla*, *Larix kaemferi*, and *Pinus koraiensis* were dominant in deciduous and coniferous plantation.

Methods

The study was conducted based on the use of radio telemetry. Eight individuals (three males and five females) of hazel grouse were captured in Dec. 1999 by luring or chasing them into nylon mist nets and they were marked with a 14-g necklace-type transmitter (Kenward 1987; Millspaugh *et al.* 2001), which weighed 4% of the bird weight. Radio-marked birds were relocated 15-20 times a week from Dec. 1999 to Jul. 2001 in the study area.

Based on study of hazel grouse behavior in Korea (Rhim *et al.* 2001), we defined the four seasons of a year as the following: spring (breeding period) was from late Mar. to early Jun., summer from middle June to early Sep., autumn from middle Sep. to Nov., and winter was from Dec.

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to middle Mar.. Territory locations and sizes used by hazel grouse were determined during each season through 25 or more relocations by using the method of Harvey and Barbour (1965). Territory size was measured from a 1:5000 map with a Kempten planimeter. Territory overlap was expressed as the mean percent overlap recorded for each territory and its neighbor. Home ranges were defined as territories that overlapped each other by more than 20% between the same sexes during the non-breeding season (Rhim 2002).

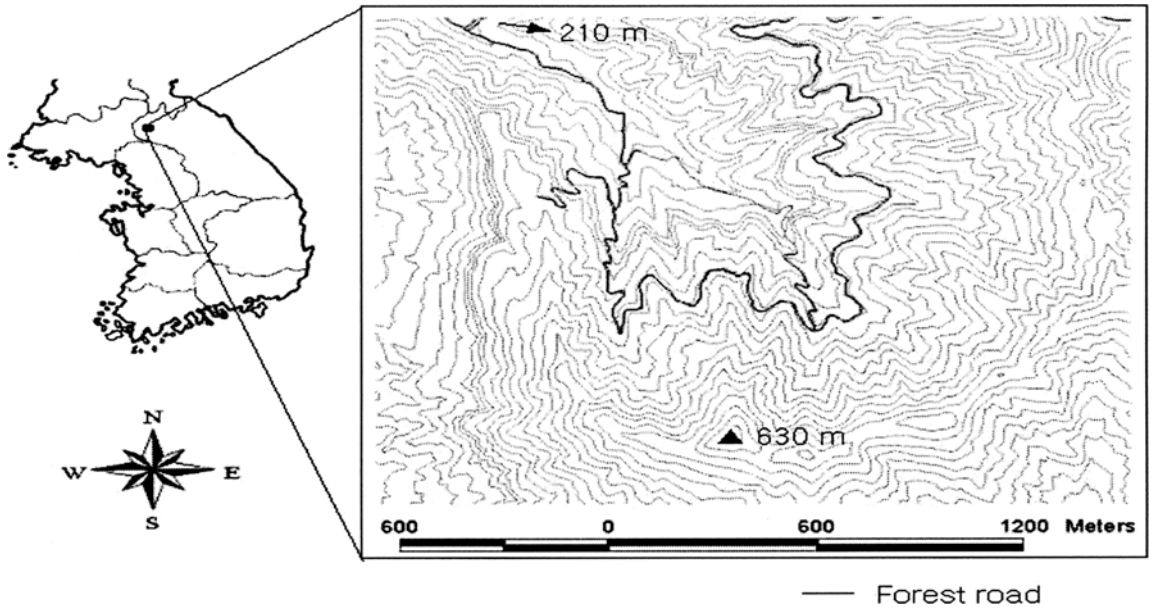

Fig. 1 The map of study area in Experimental Forest of Gangwon Forest Development Institute, Gamjeong-ri, Chuncheon, Gangwon-do Province, Korea

Index of activity was the percentage of the relocations during a month that birds were active, determined by changes in signal strength during triangulation (Swenson 1991a). Net movement was the distance between the farthest locations of a hazel grouse on every field day (Rhim 2002).

Table 1. Status and forest types of study area in Gamjeong-ri, Chuncheon, Gangwon-do Province, Korea

Forest type	Area /hm^2	Planting period	Remark
Natural deciduous forest	60		
Mixed forest	40		
Coniferous plantation	38		
Deciduous plantation	19	1967-1970	
Others	13	1980-1982	Rocks, bare area
Total	170		

Results

Mean territory overlap between consecutive seasonal territories for the same individual was relatively higher, varying from 15.6% to 65.3%. The radio-marked hazel grouse showed a high degree of site fidelity from spring to autumn. There was no significant difference between sexes in amount of overlap of seasonal territories and home ranges (two-factor ANOVA $df = 1$, $F = 0.34$, $p = 0.45$), (Table 2).

Table 2. Degree of overlap (mean ± SE) of seasonal territories or home ranges of radio-marked male and female hazel grouse on the study area

Sex	Degree of overlap between seasons (%)			
	Winter - Spring	Spring - Summer	Summer - Autumn	Autumn - Winter
Males (n = 5)	15.6±7.3	65.3±7.2	63.6±3.2	41.4±9.1
Females (n = 9)	18.2±5.4	58.9±9.4	51.4±6.7	45.3±5.6

Notes: Overlap is defined as the percentage of the first seasonal territories that is included within the second seasonal territories.

The overlap degree of home range was higher from spring to autumn, but it was significantly different between winter and spring compared with other seasons. This means that those birds moved to another habitat in winter and came back to the previous habitat in spring (Rhim 2002). These movements were not evidence of migration, because both of these males were traced by radio-tracking during the study period (Swenson *et al.* 1995).

Females were generally more active than males throughout the year. Patterns of activity rate were similar for males and females; a peak in Mar. and Oct., a sharper decline to Jul. and Jan. followed by an increase toward the breeding season. Activity peak of both males and females was in breeding season (Fig. 2).

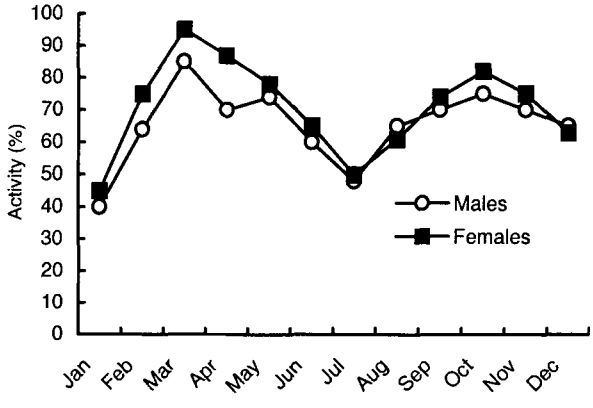

Fig. 2 Monthly activity of radio-marked males and females of hazel grouse in the study area

Although females were more active than males in spring, males were generally more mobile.

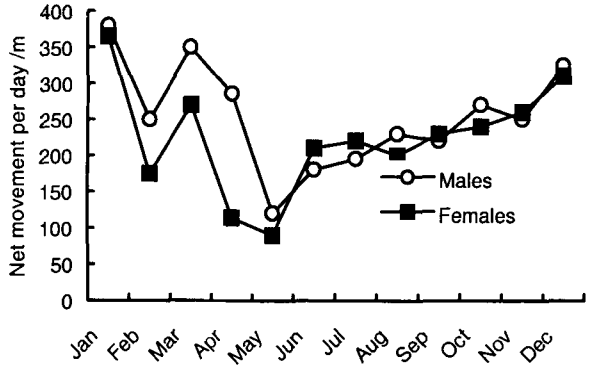

Fig. 3 Monthly net movement per day of radio-marked males and females of hazel grouse in the study area

Net movement per day also showed a rather similar pattern for males and females, peaking in late winter, sharply decreasing in Feb., sharply increasing and peaking in May, and sharply decreasing through May and increasing in Jun., with an intermediate level or an increasing rate of activity from summer to Dec. (Fig. 3).

Discussion

Both males and females of hazel grouse had more similar behavior during the non-breeding compared to the breeding season. Females were more active than males throughout the year (Fig. 2), but males were more mobile than females in spring. Both females and males had similar degree of movement from summer to winter (Fig. 3). The movement pattern differed between males and females during spring. Perhaps females were spending more time foraging (greater activity) whereas males were spending more time patrolling for intruding males and looking for females (greater mobility) (Swenson 1991; Rhim 2002).

Hazel grouse showed a very high degree of site fidelity, staying within a relatively small area throughout the year in the boreal forest of Sweden (Swenson *et al.* 1993). This species were known as site-tenacious which poorly dispersed (Swenson 1991b; Swenson *et al.* 1995; Aberg *et al.* 1995). Short dispersal distances are expected in species, which were adapted to the specific habitat that is spatially stable and contains areas within short distances in the stand (Swenson 1995). But our results showed that hazel grouse used similar areas in spring, summer, and autumn in terms of home range overlap, and greater shifts in area use occurred in winter. Thus hazel grouse used similar area from spring to autumn, after then made a shift in their area use in winter, and shifted back to previous area. This means hazel grouse move to another habitat in winter within temperate forest of South Korea.

The differences in seasonal movement and habitat use occur between boreal forest of Sweden and temperate forest of Korea. Since the reason of shift in seasonal used areas by hazel grouse has not been known in Korea, further detailed research on this aspect would be need in terms of habitat analysis.

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